

REMARKS

This application pertains to novel process and apparatus for the catalytic treatment of dust and oxygen-containing exhaust gases which also contain sulfur and nitrogen oxides.

Claims 1-19 are pending.

Claims 13-15 and 17-19 have been withdrawn from consideration as drawn to non-elected subject matter, so that the claims under consideration are claims 1-12 and 16.

Applicants respectfully request that, upon the allowance of claims drawn to the elected subject-matter, the claims drawn to the non-elected subject matter be rejoined.

Claims 1-9, 11, 12 and 16 stand rejected under 35 U.S.C. 103(a) as obvious over Inoue et al (4,221, 768) in view of Graf et al (4,810,478) and Frey et al (6,117,405).

Inoue et al disclose a process of selective removal of nitrogen oxides from oxides from exhaust and waste gases containing nitrogen oxides with ammonia in the presence of catalysts (col. 3, lines 19-28). The catalysts are divided into three groups: A, B, and C (col. 3, lines 29-43).

Inoue et al therefore teach nitrogen oxides with ammonia in the presence of catalysts. It does not teach or suggest the capture of sulfur dioxide in the presence of catalysts.

In the Inoue process, the solid acid (col. 2, line 56) is a binary oxide which consists of 5 to 95 mol% of titanium plus zirconium as $\text{TiO}_2\text{-ZrO}_2$ and 95 to 5 mol% of silicon as SiO_2 (col. 3, lines 31-35).

Applicants, by contrast, have no Zirconium or SiO_2 in their catalysts

Furthermore, the waste gases and waste gases of the Inoue process of contain sulfur oxides. More specifically, Inoue teaches a process wherein the exhaust and waste gases comprise 10 to 1,500 ppm of sulfur oxides, 1 to 20 % by volume of oxygen, 1 to 15 % by volume of carbon dioxide gas, 5 to 15 % by volume of steam, 10 to 100 mg/ Nm^3 of soot, and 100 to 1000 ppm of nitrogen oxides (col. 5. lines 25-30).

At Column 1, lines 7-18, Inoue teaches that his invention relates to catalysts for purifying exhaust and waste gases and more specifically to catalysts capable of converting nitrogen oxide , carbon monoxide and hydrocarbons contained in exhaust and waste gases containing oxygen and sulfur oxides mainly dioxide , non -toxic nitrogen, carbon dioxide and water respectively with high efficiency, and inhibiting the oxidation of sulfur dioxide (SO_2) in the exhaust gases to sulfur trioxide (SO_3).

Column 5, lines 25-38) and the Example 49 (Column 11, lines 47-68) and the results shown in Table 8 of the Inoue reference demonstrate that the catalysts of the Examples (Inoue's invention) permit a very low conversion of SO₂, namely, they have a very low stability to oxidize SO₂ to SO₃.

From Inoue's description, Example and claims it is clear that the waste gases containing sulfur dioxide (SO₂) are treated with the catalysts without oxidation to SO₃. These catalysts are used in boiler waste gases to avoid the corrosion of treating apparatus and the heat-exchanger with SO₃ and H₂SO₄. Any desulfurization (SO₂-removal) therefore must be carried out in an extra reactor.

By contrast, in Applicants' process, the denitrification (Nox-Removal) and sulfur dioxide removal are both carried out in one and the same reactor with the solid catalysts, whereby the following reactions take place, for example, in the presence of calcium: e.g refer to Applicants' example (with 5 % V₂O₅ in the catalysts)

1. SO₂ conversion to >>> SO₃ and exothermic reaction $\text{CaO} + \text{SO}_3 = \text{CaSO}_4$

and

2. $6 \text{NO} + 4 \text{NH}_3 = 5 \text{N}_2 + 6 \text{H}_2\text{O}$

SO₂ removal is 90 % and NO_x removal above 95%.

The Inoue reference cannot therefore be seen to suggest anything at all about Applicants' novel process.

Graf et al. are concerned with a process to remove SO_2 from the flue gas in a circulating fluidized bed reactor at temperatures 50 °C above the dew point temperature of water vapor, i.e. below 200 °C. In the example it is given 70°C to max. 90°C. NO_x removal is not mentioned. Naturally to capture SO_2 Graf et. al. uses sodium-, potassium-, and calcium compounds for SO_2 removal, especially calcium hydroxide. This is a different process and also no solid catalysts with flow passages are used for transformation of SO_2 to SO_3 and NO_x removal

Also one cannot combine the teaching of Inoue et. al. with the teaching of Graf et. al, because they work at different temperatures. In order to put these two processes together, one would have to install two reactors and a cooling tower in between them to reduce and control the temperatures. This would be very costly. Even then this combination would be completely different than Applicants' process, wherein the denitrification (NO_x -Removal) and sulfur dioxide removal are carried out in one and the same reactor with the solid catalysts.

In Applicants' process, the exhaust gas enters the reactor from above or from below, and the catalysts are cleaned or purged by passing the gases alternately from above or from below. This feature is also nowhere taught or suggested in the references cited.

In the Frey et al process, ammonia is added to the combusting flue gases in the post combustion stage where flue gas temperature is between 700 and 900 ° C, so that the ammonia reacts with the nitrogen oxides in the flue gases. Then flue gases are cooled to temperatures 200 to 350 °C where additional ammonia producing reducing agent is injected into the flue gases and alkaline earth metal compound sorbent or alkali metal compound sorbent are added into the flue gases, which are then passed through a catalyst / filter element coated with a catalytically active oxide or salt of vanadium, chromium etc. etc. for catalyzing the reduction of nitrogen oxides in the flue gases.

This catalyst/ filter element has the main function of separating the dust and the catalyst / filter element has gas passage opening less than 1 mm i.e. in microns. In Applicants' process, the free opening surface of the catalyst is more than 50 % and the passages of the catalyst have a hydraulic diameter of more than 2 mm.

Moreover, the composition of the coated active oxide of the Fray et al patent is not known.

At column 4 , lines 43-55, Frey teaches that the catalysts element 7 may also be designed without filter action, so that in a so-called high dust process , the flue gases R pass through the catalyst element 7 without previous dust removal A device 8 for drawing off heat may be connected downstream of the catalyst element 7, this device 8 drawing off the residual heat which still remains from the flue gases R, and cooling the flue gases R down to 160°C. Downstream of this , wet flue gas cleaning

device 9 is connected which absorbs the acidic pollutants such as SO_2 or HCl contained in flue gases R. Frey et al according to Fig. 1 requires 3 reactors.

In Applicants' process, the dust content amounts to 5000 to 10000 mg/m^3 (page 8, line 1 shows 8000 mg/m^3), and the so called high dust process and cooling of gases after catalyst and wet scrubber to absorb SO_2 is not necessary.

Frey also teaches in one embodiment that the ammonia producing reducing agent is added to the post combustion stage in an amount that is at most double the stoichiometric amount relative to nitrogen oxides in the combustion flue gases.

This means that the process of Frey et al, consumes double the amount of ammonia, with the formation of ammonium sulfate as well as emission of free ammonia into the atmosphere. This is obviously environmentally undesirable.

In Applicants' process, by contrast, the ammonia consumption is approximately stoichiometric to nitrogen oxide.

The process disclosed by Frey et al. is therefore completely different then Applicants'.

If one attempted to combine the process of Inoue et al. with catalysts inhibiting the oxidation of sulfur dioxide (SO_2) in the exhaust gases to sulfur trioxide (SO_3), Graf et. Al. desulfurization at temperatures not in the excess of 50°C above the dew point

temperature of water vapor at max. 90°C without NOx removal, and Frey et al. with catalyst / filter element with passage opening less than 1 mm mainly separating the dust and double ammonia consumption, one would require two to three reactors for desulphurization (SO₂-removal) and dinitrification (Nox-removal).

An important feature of Applicants' process is that Applicants require only one reactor.

In view of the many differences shown above, it is clear that no combination of Inoue, Graf and Frey could ever lead to Applicants' novel process.

The rejection of claims 1-9, 11, 12 and 16 under 35 U.S.C. 103(a) as obvious over Inoue et al (4,221, 768) in view of Graf et al (4,810,478) and Frey et al (6,117,405) should accordingly now be withdrawn.

It is also respectfully requested that the nonelected claims, which have the same limitations as the elected claims, be rejoined and allowed.

In view of the present remarks it is believed that claims 1-19 are now in condition for allowance. Reconsideration of said claims by the Examiner is respectfully requested and the allowance thereof is courteously solicited.

CONDITIONAL PETITION FOR EXTENSION OF TIME

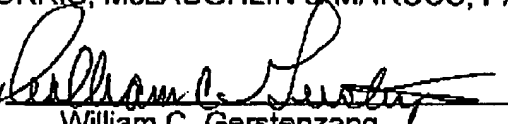
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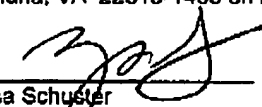
Respectfully submitted,
NORRIS, McLAUGHLIN & MARCUS, PA

By 
William C. Gerstenzang
Reg. No. 27,552

WCG/tmo

875 Third Avenue- 18th Floor
New York, New York 10022
(212) 808-0700

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By 
Zsuzsa Schuster
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